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REMARKS/ARGUMENTS

Reconsideration of this application is respectfully requested in view of the foregoing amendments and discussion presented herein.

1. Rejection of Claims under 35 U.S.C. §112, first paragraph.

The Examiner rejected Claims 1-27 under 35 U.S.C. §112, first paragraph, for failing to comply with the enablement requirement. More particularly, the Examiner stated that the claims contain subject matter which was not described in the specification in such a way as to enable one skilled in the art to which the invention pertains, or with which the invention is most nearly connected, to make and/or use the invention. The basis for the Examiner's rejection is that the specification and figures fail to teach the mechanism of bandgap radiation.

The Applicant respectfully traverses the Examiner's rejection for several reasons as explained below. Not only has the Examiner not applied the law correctly, but the Examiner has failed to understand the teachings of the Applicant's specification.

(a) The test of enablement is whether one skilled in the art could make or use the claimed invention from the disclosures in the patent coupled with information known in the art without undue experimentation. *In re Wands,* 858 F.2d 731, 737, 8 USPQ2d 1400, 1404 (Fed. Cir. 1988); *United States v. Telectronics, Inc.*, 857 F.2d 778, 8 USPQ2d 1217 (Fed. Cir. 1988). A patent need not teach, and preferably omits, what is well known in the art. *In re Buchner*, 929 F.2d 660, 661, 18 USPQ2d 1331, 1332 (Fed. Cir. 1991); *Spectra-Physics, Inc. v. Coherent, Inc.*, 827 F.2d 1524, 3 USPQ2d 1737 (Fed. Cir. 1987). See also, MPEP §2164.01.

In order to make a rejection for lack of enablement, the Examiner has the initial burden to establish a reasonable basis to question the enablement for the claimed invention. Furthermore, a specification disclosure which contains a teaching of the manner and process of making and using an invention in terms which correspond in scope to those used in describing and defining the subject matter sought to be patented must be taken as being in compliance with the nablem nt requirement of 35 U.S.C.

§112, first paragraph, unless there is a reason to doubt the objective truth of the statements contained therein which must be relied on for enabling support. It is incumbent upon the Patent Office, whenever a rejection on this basis is made, to explain why it doubts the truth or accuracy of any statement in a supporting disclosure and to back up assertions of its own with acceptable evidence or reasoning which is inconsistent with the contested statement. *In re Marzocchi*, 439 F.2d 220, 169 USPQ 367 (CCPA 1971); MPEP §2164.04. The Examiner must provide a reasonable explanation as to why the scope of protection provided by a claim is not adequately enabled by the disclosure. *In re Wright*, 999 F.2d 1557, 1562, 27 USPQ2d 1510, 1513 (Fed. Cir. 1993).

Furthermore, an applicant may overcome an examiner's doubt about enablement by pointing to details in the disclosure, by submitting factual affidavits under 37 CFR 1.132, or by citing references to show what one skilled in the art knew at the time of filing the application. MPEP §2164.05. The state of the art existing as of the filing date of the application is used to determine whether a particular disclosure is enabling as of the filing date. MPEP §2164.05(b).

(b) As long as the specification discloses at least one method for making and using the claimed invention that bears a reasonable correlation to the entire scope of the claim, then the enablement requirement is satisfied. *In re Fisher*, 427 F.2d 833, 839, 166 USPQ 18, 24 (CCPA 1970). Furthermore, if a statement of utility in the specification contains within it a connotation of how to use, and/or the art recognizes that standard modes of administration are known and contemplated, then the enablement requirement is satisfied. *In re Johnson*, 282 F.2d 370, 373, 127 USPQ 216, 219 (CCPA 1960).

(c) In the instant case, the Applicant's Specification explains that the invention comprises a structure and method of generating light emission in an integrated circuit by injecting electrons from a semiconductor or metal surface through an insulating layer that are collected in a direct bandgap film that converts the collected

electrons into bandgap radiation. See, page 3, lines 12-15. The Specification clearly teaches the structure and use of a light emitting device or integrated circuit according to the invention as follows: a light emitting layer or film comprising a direct bandgap semiconductor material such as GaInP is deposited on an insulating oxide layer or film, such as SiO_2, which covers an electron emitting layer or film such as polysilicon. The GaInP may be deposited by evaporation, sputter deposition, or organometallic vapor phase epitaxy, for example, as is known in the art. The GaInP will not then be single crystal when deposited on the SiO_2 surface, but such material is suitable to convert electrons emitted from the polysilicon and injected into the GaInP into direct bandgap radiation (citing Shealy et al., "Direct band gap structures on nanometer-scale, micromachined silicon tips", Appl. Phys. Lett., Vol. 70, No. 25, pp. 3458-3460, June 1997, which was incorporated by reference). As further explained in the Specification, the radiation from the GaInP creates light emission from the silicon. The SiO_2 layer is preferably on the order of tens of nanometers in thickness. Furthermore, the oxidized polysilicon layer is preferably formed in a manner that promotes the formation of asperities on the surface of the polysilicon that promote field emission of electrons into the SiO_2 layer overlying the polysilicon layer. See, page 5, lines 2-20.

The Specification goes on to explain that the properties of oxidized polysilicon formed in a manner that promotes asperities and characteristics of field emission of electrons are well known in the art, and incorporates by reference three publications in support of that statement. The Specification further teaches that various techniques of fabrication of the described device are known in the art as well. See, page 5, line 21 through page 6, line 5.

Note also that the Specification not only teaches fabrication of the device but also teaches how to achieve light emission. Namely, the Specification teaches that to cause light emission to take place, a potential of approximately five to approximately twenty volts is applied between the GaInP layer 12 and the polysilicon layer 16. The Specification teaches that the voltage chosen varies bas d on the oxidation condition of

the polysilicon, the thickness of the final SiO_2 layer over the polysilicon, and the bandgap of the GaInP material. Furthermore, the Specification teaches that the potential applied is positive with on the GaInP with respect to the polysilicon so as to attract electrons from the polysilicon into the GaInP layer. This enhances electron emission from the polysilicon and ensures that electrons are emitted from the polysilicon and arrive and are injected into the GaInP with sufficient energy to create bandgap light to be emitted from the GaInP layer. Electrons are thus injected through the SiO_2 and into the GaInP layer from the sharp asperities on the surface of the polysilicon with enough energy to allow bandgap radiation to be emitted from the GaInP layer. See, page 6, lines 6-17.

(d) As can be seen from the discussion of the Specification in paragraph (c) above, the Applicant has taught the structure of a light emitting device according to the invention, various physical characteristics associated with the device, and how to cause light emission to take place. Furthermore, as explained in paragraphs (a) and (b) above, the Examiner has the initial burden to establish a reasonable basis to question the enablement for the claimed invention. In the instant case, however, the Examiner has not provided any basis whatsoever to question the teachings of the Applicant's Specification. Again, a specification which contains a teaching of the manner and process of making and using an invention in terms which correspond in scope to those used in describing and defining the subject matter sought to be patented <u>must be taken as being in compliance with the enablement requirement of 35 U.S.C. §112, first paragraph, unless there is a reason to doubt the objective truth of the statements contained therein which must be relied on for enabling support</u>.

(e) Notwithstanding the teachings discussed in paragraph (c) above, the Examiner states one of ordinary skill in the art could not make and/or use the invention. In support of that conclusion, the Examiner merely states that there are several ways to generate photons using direct bandgap materials, that the Applicant fails to disclose in the specification whether the mechanism involves carrier recombination or electron-hole

generation or other mechanisms, and that the Applicant fails to disclose the concentration and conductivity type of the light-emitting layer. Yet, the Examiner has not explained why one of ordinary skill in the art could not make and/or use the invention without those parameters being expressly stated. Therefore, the Examiner has not refuted the Applicant's teachings; to the contrary, the Examiner has called into question the Applicant's teachings simply because the Examiner does not understand physics behind the Applicant's invention. Note that the test of enablement is not whether the Examiner understands how to make and/or use the invention but whether one of ordinary skill in the art would understand how to make and/or use the invention.

(f) Notwithstanding the fact that it is one of ordinary skill, not the Examiner, who must be able to make and/or use the invention from the teachings of the Specification, the Applicant will explain the physics to the Examiner. To being with, bandgap energy is an electronic property and the commonly used definition of bandgap energy is the energy difference between the bottom of the conduction band and the top of the valence band in a semiconductor or an insulator material. Bandgap energy, for example, is typically measured in electron volts (eV) and changes as a result of quantum confinement effect.

While the exact mechanism of "bandgap radiation" is not taught in the Specification, it is a term of art that is discussed in virtually every entry level course in Semiconductor Device Physics or Electronics; therefore, there is no requirement that the Specification teach that which one of ordinary skill in the art would already know. For example, refer to the following excerpts from learned treatises attached hereto: (i) S. M. Sze, "Physics of Semiconductor Devices", page 46, page 47 (Fig. 24), page 690, page 691 and Fig. 2; A. S. Grove, "Physics and Technology of Semiconductor Devices", page 128, Fig. 5.10; (iii) Donald A. Neaman, "Semiconductor Physics & Devices - Basic Principles", page 67; and (iv) Sima Dimitrijev, "Understanding Semiconductor Devices", Fig. 8.10. The teachings of the foregoing show that the mechanism of bandgap radiation is well known to one of ordinary skill in the art and

does not need to be separately taught by the Applicant. Note also the discussion in the foregoing references of "direct" as opposed to "indirect" bandgap or band to band transitions.

One of ordinary skill in the art, from the teachings of the Applicant's Specification, would readily understand the mechanisms of producing light in accordance with the present invention. For example, in one embodiment, electrons are injected into direct bandgap film. These injected electrons would then be excess electrons that undergo a band-to-band transition in a direct material by dropping from the bottom of the conduction band with holes at the top of the valence band by simultaneously producing photons of bandgap energy $Eg= h\nu$, where h is Plank's constant and Eg is the bandgap energy and ν is the frequency of the light emitted. In other words, the injected electrons are collected in the deposited film of electro-optical material and then either directly recombine with holes to produce band-to-band light or, if the energy of the collected electrons have sufficient energy, they generate hole-electron pairs which then recombine by band-to-band recombination to produce light of a frequency ν. See, Specification, page 3, lines 12-15; page 3, line 20 through page 4, line 5; and page 6, lines 6-17.

From the foregoing, the Examiner should appreciate what one of ordinary skill in the art would readily understand from the teachings of the Applicant's Specification. However, as stated before, the Applicant is not required to teach the Examiner but one of ordinary skill in the art how to make and/or use the invention without undue experimentation. Note also, that one of ordinary skill in the optoelectronic art uses the terms "band-to-band" radiation and "bandgap radiation" interchangeably. The word "direct" is sometimes used in the Applicant's specification and claims to denote a bandgap or band-to-band transition of electrons in a direct, not an indirect semiconductor material.

(g) Furthermore, there is a fundamental flaw in the Examiner's conclusion that it is n cessary to know whether the mechanism involves carrier recombination or

electron-hole generation or other mechanisms. The photon generation process is not caused by generation; rather it occurs by direct conduction band to valence band transitions resulting from the excess injected electrons and possibly recombination of hole-electron pairs created by the energetics of the injected electrons. And, it is not necessary to teach or even understand the exact mechanism; it is sufficient to teach how to establish bandgap radiation which results in light emission. That is clearly taught by the portions of the Applicant's Specification discussed in paragraph (b) above either with or without resort to the general knowledge possessed by one of ordinary skill in the art. And, with regard to the Examiner's apparent need to know the concentration and conductivity type of the light-emitting layer (e.g., the GaInP layer), there is no basis for the Examiner to conclude that such information would be need to be taught by the Applicant to one of ordinary skill in the art.

(h) In conclusion, the Applicant respectfully submits that the invention as claimed is fully enabled by the Specification. Use of the term "bandgap radiation", as well as related terms such as "direct bandgap", "direct bandgap semiconductor" and "direct bandgap layer", used in the Specification and claims do not support a conclusion by the Examiner that the invention is not enabled under 35 U.S.C. §112, first paragraph, or that the claims are indefinite under 35 U.S.C. §112, second paragraph. One of ordinary skill in the art to which the invention pertains would readily understand how to make and/or use the invention without undue experimentation from the teachings of the Applicant, and the Examiner has not presented any evidence to the contrary. Accordingly, the rejection of Claims 1-28 under 35 U.S.C. §112, second paragraph, should be withdrawn.

2. <u>Rejection of Claims 8 and 10</u>.

Claims 8 and 10 were rejected under 35 U.S.C. §102(b) as being anticipated by Beemink et al. (U.S. No. 5,717,707) or in the alternative as being obvious under 35 U.S.C. §103 in view of Beemink et al. In support of the rejection, the Examiner stated that Beemink et al. teach s th el ments of Claims 8 and 10 except for an oxidized

polysilicon layer, and further stated that Beernink et al's diffused silicon layer (58) is inherently polysilicon and that the Examiner interprets Beernink et al's silicon layer (58) with oxide on top of it as an oxidized polysilicon layer.

The Applicant respectfully traverses the rejection based on the Examiner's conclusion that Beernink's diffused silicon layer is polysilicon. Beernink et al. does not teach, suggest or provide motivation or incentive for a light emitting structure having a polysilicon layer as recited in Claims 8 and 10 and there is no basis for the Examiner's conclusion that a diffused silicon layer is polysilicon.

(a) "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.' " *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999).

(b) Additionally, "[i]n relying upon the theory of inherency, the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art." Ex parte Levy, 17 USPQ2d 1461, 1464 (Bd. Pat. App. & Interf 1990).

(c) Based on the foregoing line of cases, in order to based on rejection on inherency the Examiner must provide objective evidence or cogent technical reasoning to support the conclusion of inherency. See, MPEP §2112. In the present application, however, the Examiner has not presented any objective evidence or technical reasoning to support the Examiner's conclusion of inherency. Instead, all the Examiner has done is to state that Beernink et al's "diffused silicon layer (58) is inherently polysilicon." Furthermore, the Examiner's conclusion of inherency is inconsistent with semiconductor device physics as well as the teachings of the cited reference.

(d) To state that a diffused silicon layer is inherently polycrystalline is so fundamentally incorrect that the Applicant is clearly confused by the Examiner's basis for rejection. A diffused silicon layer is not equivalent to polysilicon and use of a polysilicon layer does not flow from use a diffused silicon layer. Polysilicon is a thin film of polycrystalline silicon (also known as poly-Si or poly). This is to be contrasted with single crystal silicon which has different material characteristics, or diffused silicon which is generally understood by those skilled in the art as silicon that has been doped.

(e) For example, polysilicon is more resistive than single-crystal silicon for any given level of doping because the grain boundaries in polysilicon hamper carrier mobility. Common dopants for polysilicon include arsenic, phosphorus, and boron. Polysilicon is usually deposited undoped, and the dopants (if any) are introduced after deposition. There are three ways to dope polysilicon, namely, diffusion, ion implantation, and in situ doping. Diffusion doping consists of depositing a very heavily-doped silicon glass over the undoped polysilicon. This glass will serve as the source of dopant for the poly-Si. Dopant diffusion takes place at a high temperature, i.e., 900-1000 deg C. Ion implantation is more precise in terms of dopant concentration control and consists of directly bombarding the poly-Si layer with high-energy ions. In situ doping consists of adding dopant gases to the CVD reactant gases during the epi deposition process.

(f) Concluding, as the Examiner has, that diffused silicon is inherently polysilicon is a non sequitor. Diffusing silicon with a dopant does not render the silicon polycrystalline. Again, the term "poly" in "polysilicon" does not mean that the silicon contains other materials such as diffused dopants; it means "polycrystalline" silicon. Therefore, the Applicant respectfully submits that the Examiner's rejection of Claims 8 and 10 lacks proper foundation and should be withdrawn.

(g) Furthermore, there is nothing in Beernink et al. from which one of ordinary skill in the art would find any suggestion, motivation or incentive to employ a polysilicon layer. Beernink's diffused silicon region (58) is single crystal silicon into which an n-type

dopant (e.g., phosphorus) has been diffused. More specifically, Beemink et al.'s device is made with single crystal lattice matched heteroepitaxial layers of optoelectronic materials. Polysilicon is not interchangeable or compatible with Beemink's diffused single crystal silicon and would not provide the required functionality in Beemink's device.

In fact, Beemink et al. teaches away from the use of polysilicon by employing single crystal lattice matched heteroepitaxial layers, and the Applicant's invention of Claims 8 and 10 employs fundamentally different principles. More specifically, in the Applicant's invention, the direct bandgap semiconductor films do not have to be lattice matched since they do not have to be single crystal and the SiO_2 layer that they are attached to is an amorphous material; thus lattice matching is not even a consideration.

Because the direct bandgap semiconductor films of the Applicant's invention do not have to be single crystals, they can be deposited using a variety of well known techniques such as evaporation, sputter deposition or CVD which are very simple and inexpensive compared with Molecular Beam Epitaxy (MBE) or Metal Organic Chemical Vapor Deposition (MOCVD) which are the complex, expensive procedures used with direct bandgap semiconductor material using single crystal heteroepitaxy as in Beemink et al. Such complex expensive heteroepitaxial growth techniques used in conventional optoelectronic structures used to make a variety of semiconductor lasers and light emitting structures also require complex lattice matching techniques to create the formation of multilayer single crystal materials. For additional understanding of the complex lattice matching required for single crystal structures such as taught by Beernink et al. refer to James W. Mayer and S.S. Lau, "Electronic Materials Science: For Integrated Circuits in Si and GaAs", pages 431-435, which is attached hereto.

Accordingly, there is nothing in Beernink et al. from which one of ordinary skill in the art would find motivation or incentive for the invention of the Applicant's Claims 8 and 10 or which would otherwise render obvious those claims in view of Beemink.

Therefore, the Application respectfully submits that the rejection of Claims 8 and 10 should be withdrawn.

3. Rejection of Claim 13.

Claim 13 was rejected under 35 U.S.C. §102(b) as being anticipated by Beemink et al. in support of the rejection, the Examiner stated that Beemink et al. teaches an electron-emitting layer (58) and a GalnP layer (66) over the electron-emitting layer, that by applying appropriate voltage to the n+ diffused region (58) electrons can be ejected from it, and that the n+ diffused region (58) is inherently and electron-emitting layer.

In response, the Applicant notes that Claims 13-15 have been canceled and, therefore, the rejection is moot. Cancellation of Claims 13-15 is without prejudice or disclaimer of the subject matter thereof.

4. Claims 1-7, 9, 11-12 and 14-28.

The Applicant notes that Claims 1-7, 9, 11-12 and 14-28 were not rejected based on any references of record. Accordingly, those claims are considered to be in a condition for allowance.

Notwithstanding the foregoing, the Applicant notes that Claims 1-7, 9, 11-12 and 14-28 recite subject matter which is neither taught nor rendered obvious by the cited references. Claims 1, 17 and 27 have each been amended to recite that the electron emitting layer comprises polysilicon, which is not taught or rendered obvious by the cited references as discussed above. Claims 2 and 18, which were dependent claims reciting polysilicon have been canceled in view of such amendments. Each of the remaining independent claims (Claims 6, 8, 10, 22, 24 and 25) also recite polysilicon. The complex expensive heteroepitaxial growth techniques used in conventional optoelectronic structures used to make a variety of semiconductor lasers and light emitting structures, such as in Beemink et al., require complex lattice matching techniques to create the formation of multilayer single crystal materials. In contrast, lattice matching is not an issue in the Applicant's invention because the polysilicon film

is not single crystal and the insulator layer to which the film is attached is an amorphous material.

Furthermore, independent Claims 1, 6, 8, 17 and 22 have been amended to recite the use of a direct bandgap layer over the polysilicon layer. The remaining independent claims (Claims 8, 10, 24, 25 and 27) also recite use of a direct bandgap material (or GaInP which is a direct bandgap material). In the Applicant's invention, "hot" electrons are injected across an insulator into a direct bandgap material by using the property of oxidized polysilicon that creates asperities at the polysilicon/insulator interface ands allows electron injection into the insulator and transport across the insulator into the direct bandgap semiconductor material at very low voltages. These asperities avoid the need for high voltages or sharp, difficult to create, expensive tips.

The cited references do not address the foregoing or suggest or provide motivation or incentive for a structure as recited in the Applicant's claims which provides the advantages described above.

5. <u>Conclusion</u>.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

The Applicant also respectfully requests a telephone interview with the Examiner in the event that there are questions regarding this response, or if the next action on the merits is not an allowance of all pending claims.

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Respectfully submitted,

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